

Bivalves of the São Sebastião Channel, north coast of the São Paulo State, Brazil

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ABSTRACT: The north coast of the São Paulo State, Brazil, presents great bivalve diversity, but knowledge about these organisms, especially species living subtidally, remains scarce. Based on collections made between 2010 and 2012, the present work provides a species list of bivalves inhabiting the intertidal and subtidal zones of the São Sebastião Channel. Altogether, 388 living specimens were collected, belonging to 52 species of 34 genera, grouped in 18 families. Tellinidae, Veneridae, Semelidae, Ungulinidae, Mactridae, Solecurtidae, Corbulidae, Cardiidae, Lucinidae, Cooperellidae, Nucleidae, Psammobiidae, Donacidae, Solenidae, Periplomatidae, Thraciidae and Arcidae were the most representative families in this collection. Among the identified species, *Caryocorbula caribaea*, *Codakia pectinella* and *Diplodonta punctata* were intertidally abundant, while *Macoma uruguayensis* and *Pitar fulminata* were subtidally abundant.

INTRODUCTION

The municipalities of São Sebastião and Ilhabela are within an area of important biodiversity along northern coast of São Paulo State. Between the continent and Ilhabela island is the São Sebastião Channel (Figure 1). In this area, marine communities have been irreversibly altered because of exponential urban growth and anthropogenic influence in coastal zones. The commercial harbor at São Sebastião, an oil terminal (Dutos e Terminais Centro Sul - DTCS) (Zanardi *et al.* 1999), and two submarine outfalls (one on the mainland, near the harbor at the Araçá Bay, and another at Saco da Capela, in Ilhabela municipality) have increasingly contributed to local contamination by chemical compounds. Furthermore, much attention has been given to this area due to an expansion of the harbor at São Sebastião, which requires information about environmental impact to marine ecosystems at the region (Teodoro *et al.* 2010).

In this context, all knowledge on ecological dynamics of coastal and oceanic areas represents important contributions to the evaluation and monitoring of environmental quality. New information is essential to planning and can draw attention to the preservation and sustainability of this delicate natural heritage in São Paulo State (Arasaki *et al.* 2004; Amaral *et al.* 2010; Teodoro *et al.* 2010).

São Sebastião Channel has been an important hub for scientific research due to its variety of habitats and biodiversity. Mollusks are conspicuous among the invertebrate groups found in this region (Amaral *et al.* 2010). Bivalves contribute to the conduction of nutrients from the pelagic to the benthonic zone, are considered key

elements in trophic chains and are commercially relevant. Estimates suggest that there are about 1,000 marine bivalve species in Brazil; approximately 300 of these are believed to occur in São Paulo State, but only 191 were published (Simone 1999).

Despite the importance of bivalves in the marine environment, there are few details on their distribution, especially on those species living subtidally at greater depths. Malacofaunal studies in the São Sebastião Channel include the pioneer survey of Ihering (1897), as well as the study of Migotto *et al.* (1993), which analyzed several locations along the channel, and the investigation of Salvador *et al.* (1998), which focused on the central-northern beaches of Ilhabela.

Considering the absence of current data on bivalve diversity and distribution within the intertidal and subtidal zones of the north coast of the São Paulo State, this work aims to present an updated list of bivalve species within the São Sebastião Channel.

MATERIALS AND METHODS

São Sebastião Channel is located between the municipalities of São Sebastião and Ilhabela on the north coast of São Paulo State, southeast Brazil; it is 25 km long, 2–7 km wide and up to 40 m deep in the central area (Netto *et al.* 2005; Oliveira *et al.* 2010). The climate is subtropical and water temperatures oscillate from 15 to 20°C (Migotto *et al.* 2001).

The bivalves were obtained from sediment samples collected in the intertidal and subtidal zones between January 2010 and December 2012. Only living specimens with soft parts were considered in this survey.

Anomalocardia brasiliensis, a species with great ecological and socioeconomic importance, was not included in this study, despite the huge biomass and conspicuous populations in certain sampling localities such as Araçá Bay. This species has a high nutritional value and supplies food for local fishermen and tourists (Amaral *et al.* 2010). *Anomalocardia brasiliensis* was excluded from the present study because it has been investigated in other studies (Narchi 1974; Arruda-Soares *et al.* 1982; Boehs 2000; Arruda and Amaral 2003; Amaral 2010; Boehs *et al.* 2010).

A Global Positioning System device (Garmin GPSMAP 60CSx) was used to record positions of the stations. Intertidal sediment samples were collected using shovels and 0.5 mm sieve mesh. Samples were gathered on four different dates at Araçá Beach ($23^{\circ}49.053' \text{ S}$, $45^{\circ}24.373' \text{ W}$), three different dates at Barequeçaba Beach ($23^{\circ}49' \text{ S}$, $45^{\circ}25' \text{ W}$), both in São Sebastião, as well as twice at Velho Barreiro Beach ($23^{\circ}45' \text{ S}$, $45^{\circ}20' \text{ W}$) and once at the Engenho D' água Beach ($23^{\circ}48' \text{ S}$, $45^{\circ}22' \text{ W}$), in Ilhabela (Figure 1). Subtidal bottom samples were obtained using a *Van Veen*-type floor sediment collector, towed from a trawl boat. Subtidal samples were washed and sieved over 0.3 and 0.5 mm mesh sizes. The following subtidal localities were sampled once: two locations at 200 meters from the Figueira Pier in São Sebastião ($23^{\circ}45.138' \text{ S}$, $45^{\circ}24.070' \text{ W}$ and $23^{\circ}45' \text{ S}$, $45^{\circ}24' \text{ W}$), two stations in the middle of the

Channel, between São Sebastião and Ilhabela ($23^{\circ}46.745' \text{ S}$, $45^{\circ}23.091' \text{ W}$ and $23^{\circ}43.887' \text{ S}$, $45^{\circ}22.420' \text{ W}$), two stations at the Araçá Bay ($23^{\circ}49.002' \text{ S}$, $45^{\circ}24.159' \text{ W}$ and $23^{\circ}48.872' \text{ S}$, $45^{\circ}23.990' \text{ W}$), one station near the Cigarras Beach, São Sebastião ($23^{\circ}43.760' \text{ S}$, $45^{\circ}23.771' \text{ W}$) and one station at the Azeda Beach, Ilhabela ($23^{\circ}44.622' \text{ S}$, $45^{\circ}20.961' \text{ W}$) (Figure 1).

All specimens were immediately submersed in seawater and kept alive for transport to the Marine Biology Center, São Paulo University (CEBIMar-USP), where they were dissected for other purposes. Foot and adductor muscle tissues were fixed in 95% alcohol for molecular analyses and gonads were prepared for electron/light microscopy. The remaining soft parts and shells of the voucher specimens were deposited in the Museum of Zoology "Prof. Dr. Adão José Cardoso" (ZUEC), in the State University of Campinas (Table 1). Species identifications were based on Rios (1994, 2009), Mikkelsen and Bieler (2008), Quast (2003), Arruda (2005), Amaral *et al.* (2006), and Denadai *et al.* (2006), while suprageneric nomenclature and taxonomic order follow Bieler *et al.* (2010).

Images of shells were made using a stereomicroscope (Stereo Discovery V8, Carl Zeiss Microscopy) and a Canon digital camera (Figures 2-4). Some specimens were slightly damaged during dissection and other, well-preserved specimens from the teaching collection of State University

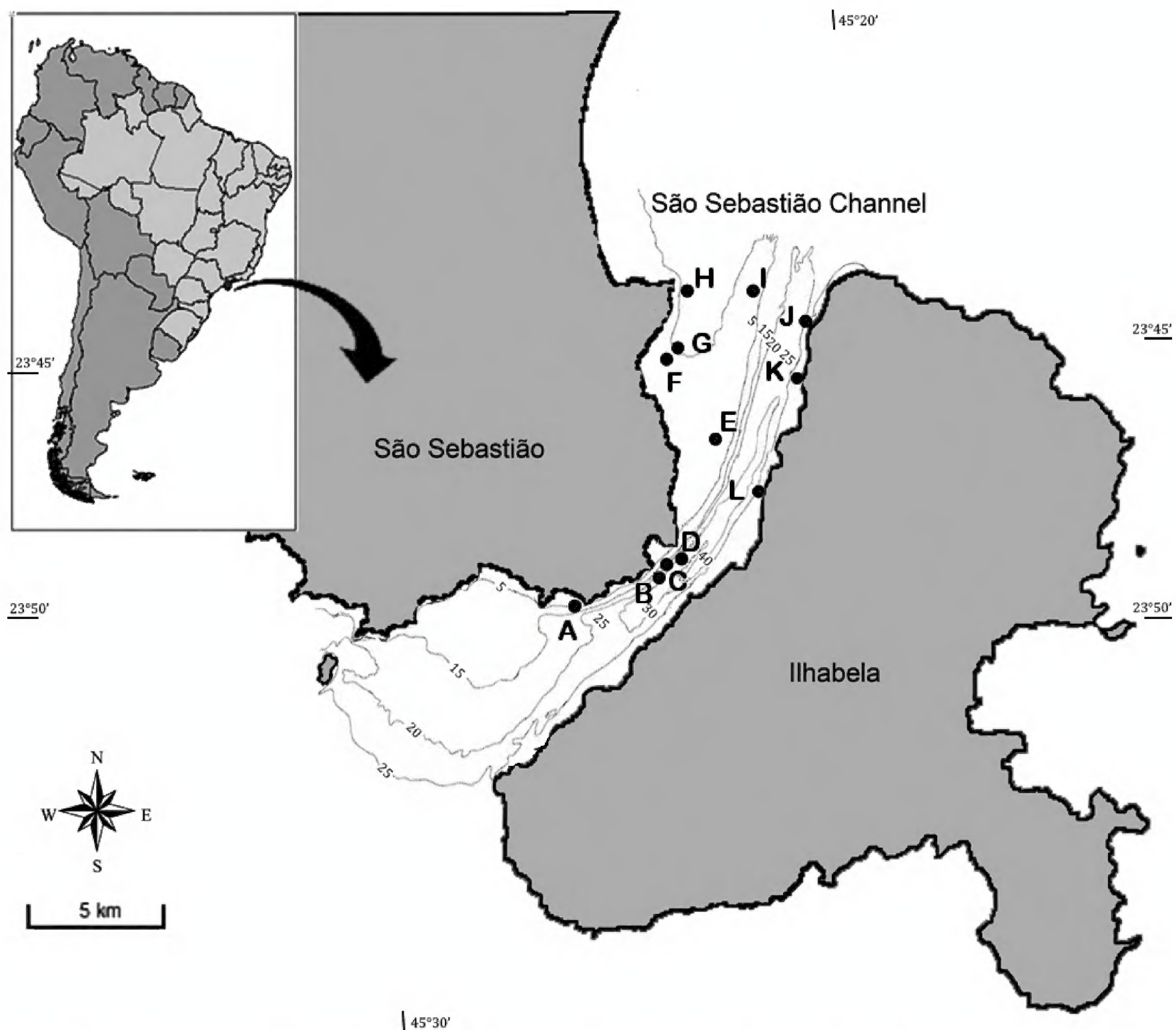


FIGURE 1. Collection stations on the northern coast of the São Paulo State: (A) Barequeçaba Beach; (B) Araçá Beach; (C and D) Araçá Bay; (E and I) São Sebastião Channel; (F and G) São Sebastião Channel near Figueira Pier; (H) Cigarras Beach; (J) Azeda Beach; (K) Velho Barreiro Beach; (L) Engenho D' água Beach.

of Campinas were photographed instead. However, all rare specimens collected as part of this study were all photographed.

RESULTS

Altogether 388 living individuals and 52 species of bivalves were collected. They belong to 34 genera, grouped in 18 families and five orders (Table 1, Figures 2-4).

A total of 330 specimens belonging to 43 species were found in the intertidal zone, while 58 specimens belonging to 22 species were found in the subtidal zone. The most frequently collected bivalve families were, in diminishing order of number of species: Tellinidae, Veneridae, Semelidae, Ungulinidae, Mactridae, Solecurtidae, Corbulidae, Cardiidae, Lucinidae, Cooperellidae, Nuculidae, Psammobiidae, Donacidae, Solenidae, Periplomatidae, Thraciidae and Arcidae. The most speciose families in both intertidal (Figure 5A) and subtidal (Figure 5B) zones were Tellinidae and Veneridae.

The abundant species exclusively found within the intertidal zone were *Diplodonta punctata* (Figure 2.8) at Velho Barreiro Beach, *Codakia pectinella* (Figure 2.6) at Engenho D'água Beach, and *Caryocorbula caribaea* (Figure 3.48) at Araçá Beach. However, the most abundant species in the subtidal zone, during one collection event, were *Macoma uruguayensis* (Figure 2.22) and *Pitar fulminata* (Figure 3.42).

A few species were exclusively found in the subtidal zone: *Anadara chemnitzii* (Figure 2.3), *Anatina anatina* (Figure 3.45), *Caryocorbula chittyana* (Figure 4.49), *Chione subrostrata* (Figure 3.38), *Cyclinella tenuis* (Figure 3.39), *Juliacorbula aequivalvis* (Figure 4.50), *Macoma uruguayensis*, *Solecurtus sanctaemarthae* (Figure 2.17), *Strigilla producta* (Figure 3.25) and *Tellina trinitatis* (Figure 3.30). Others were distributed both in the subtidal and intertidal zones: *Chione cancellata* (Figure 3.35), *Chione paphia* (Figure 3.36), *Pitar fulminata*, *Tellina exerythra* (Figure 3.27), *Tellina versicolor* (Figure 3.32), *Abra lioica* (Figure 2.12), *Tagelus divisus* (Figure 2.18), *Caryocorbula caribaea*, *Laevicardium brasilianum* (Figure 2.4), *Codakia pectinella* (Figure 2.6), *Cooperella atlantica* (Figure 3.44) and *Nucula semiornata* (Figure 2.1).

Sanguinolaria sanguinolenta (Figure 2.11) and *Donax gemmula* (Figure 2.16) were only found at the Barequeçaba Beach. Large numbers of *Strigilla carnaria* (Figure 2.23) and *Strigilla pisiformis* (Figure 2.24) were also found on this beach.

Araçá Bay is formed by sand and mud sediments and is one of the last remaining mangrove locations in the region. The bay has a high number of species. In six collections 93 individuals belonging to 22 species were found.

The collections from Engenho D'água Beach (one station) and Velho Barreiro Beach (two stations) show a large number of species. At Engenho D'água Beach, 108 specimens belonging to 19 species were found. At Velho Barreiro Beach, 72 specimens belonging to 15 species were collected.

DISCUSSION

Ecological studies on bivalves from the southeastern Brazilian coast found between 45 and 90 species in each area studied (Ihering 1897; Migotto 1993; Salvador et

al. 1998; Soares-Gomes and Pires-Vanin 2003). Ihering (1897) collected 79 species in São Sebastião and Ilhabela. Migotto (1993) described 87 species collected in southern São Sebastião Channel, from Ponta do Guaecá to Araçá Bay. Salvador (1998) found 52 species from Barra Velha, Perequê and Engenho D'água beaches. Soares-Gomes and Pires-Vanin (2003) collected 59 samples from the Ubatuba continental shelf. In the present study, 52 species were found in São Sebastião Channel (Table 1), but differing collection methodologies and different locations do not allow in-depth comparison with earlier studies.

No new species were found during the present study, but some uncommon species were collected, including *Anadara chemnitzii*, *Cooperella atlantica*, *Pitar circinata*, *Sanguinolaria sanguinolenta*, *Strigilla pisiformis*, *Solecurtus sanctaemarthae* and *Thracia similis* (Figure 4.51) (Coltro 1997). Ihering (1897) recorded *Sanguinolaria sanguinolenta* and *Strigilla pisiformis* at Ilhabela beaches, but these species were only found at the Barequeçaba Beach in this survey. Some species collected in the present study but not found by Migotto et al. (1993) and Salvador et al. (1998) were: *Anatina anatina*, *Caryocorbula chittyana*, *Codakia pectinella*, *Cooperella atlantica*, *Felaniella candeana* (Figure 2.9), *Juliacorbula aequivalvis*, *Periploma ovatum* (Figure 4.52), *Sanguinolaria sanguinolenta*, *Solecurtus sanctaemarthae*, *Strigilla pisiformis* and *Strigilla producta*.

Due to possibly insufficient search effort at some sites, species previously reported in other studies were not found. The absence of such species in our data does not necessarily show that they are no longer extant in the area. Thus, we cannot state that the absence of certain species in our survey represents a reduction in biodiversity.

Willig et al. (2003) and Ricklefs (2004) suggest a pluralistic approach to study biodiversity, considering that there is not a universal criterion to measure it within a specified geographic area. Factors that influence biodiversity are not fully understood, although weather, climate stability, spatial heterogeneity, physical disturbances of the environment, sediment type, competition, predation and productivity are likely important. More heterogeneous environments are related to higher species richness (Soares-Gomez and Pires-Vanin 2003).

Water current and sediment type may contribute to the distribution of bivalve species in São Sebastião Channel. Seasonal dynamics of water masses in the channel greatly influences the marine biota (Migotto et al. 2001). Some localities contain a wide range of sediment sizes from sand and gravel grain classes to silt or clay, and this heterogeneity has been related to abundance of bivalves (Denadai et al. 2005). Araçá Bay, Engenho D'água and Velho Barreiro beaches have these heterogeneous sediments and favorable water currents.

The data in this study serve as a baseline for future investigations of the malacofauna of São Sebastião Channel. These results will be useful in preparing management plans for the preservation of this natural heritage. In addition, these data are important because they add to the general malacological knowledge of the northern coast of São Paulo State.

TABLE 1. Species, number of bivalves and voucher numbers collected in São Sebastião Channel, northern coast of the São Paulo State. Abbreviation: (A) Barequeçaba Beach; (B) Araçá Beach; (C and D) Araçá Bay; (E and I) São Sebastião Channel; (F and G) São Sebastião Channel near Figueira Pier; (H) Cigarras Beach; (J) Azeda Beach; (K) Velho Barreiro Beach; (L) Engenho D'água Beach.

CLASSIFICATION	SPECIES	VOUCHER LOT NUMBERS (ZUEC)												
Order Nuculoida														
Family Nuculidae	<i>Nucula semiornata</i> d'Orbigny, 1846	3439, 3780 (Figure 2.1), 3840, 3841, 3839												
Order Arcoïda														
Family Noetiidae	<i>Arcopsis adamsi</i> (Dall, 1886)	3823 (Figure 2.2)												
Family Arcidae	<i>Anadara chemnitzii</i> (Philippi, 1851)	3843												
Order Veneroïda														
Family Cardiidae	<i>Laevicardium brasilianum</i> (Lamarck, 1819)	-	-	-	-	-	-	-	-	-	1	7	2	10
	<i>Trachycardium muricatum</i> (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	3	-	3
Family Lucinidae	<i>Codakia pectinella</i> (C.B. Adams, 1852)	-	-	-	-	-	-	-	-	1	1	9	48	59
	<i>Lucina pectinata</i> (Gmelin, 1791)	-	1	-	-	-	-	-	-	-	-	-	-	1
Family Ungulinidae	<i>Diplodonta punctata</i> Say, 1822	-	-	-	-	-	-	-	-	-	-	32	7	39
	<i>Felaniella candeana</i> (d'Orbigny, 1842)	-	5	-	-	-	-	-	-	-	-	-	4	9
	<i>Phlyctiderma semiaspera</i> (Philippi, 1836)	-	-	-	-	-	-	-	-	-	-	1	-	1
Family Psammobiidae	<i>Sanguinolaria sanguinolenta</i> (Gmelin, 1791)	7	-	-	-	-	-	-	-	-	-	-	-	7
Family Semelidae	<i>Abra lioica</i> (Dall, 1881)	-	5	-	-	-	-	-	2	-	-	1	8	8
	<i>Ervilia nitens</i> (Montagu, 1806)	-	-	-	-	-	-	-	-	-	-	2	-	2
	<i>Semele proficua</i> (Pulteney, 1799)	-	-	-	-	-	-	-	-	-	-	-	-	13
	<i>Semele purpurascens</i> (Gmelin, 1791)	-	1	-	-	-	-	-	-	-	5	1	7	7
Family Donacidae	<i>Donax gemmula</i> Morrison, 1971	-	-	-	-	-	-	-	-	-	-	1	1	1
Family Solecurtidae	<i>Solecurtus sanctaemarthae</i> d'Orbigny, 1842	-	-	-	-	-	-	-	1	-	-	-	-	1
	<i>Tagelus divisus</i> (Spengler, 1794)	-	3	-	-	-	2	-	-	-	-	-	-	5
	<i>Tagelus plebeius</i> (Lightfoot, 1786)	-	2	-	-	-	-	-	-	-	-	-	-	2
Family Tellinidae	<i>Macoma cleryana</i> (d'Orbigny, 1846)	-	-	-	-	-	-	-	-	-	2	2	4	4
	<i>Macoma constricta</i> (Bruguière, 1792)	-	4	-	-	-	-	-	-	-	-	-	-	4
	<i>Macoma uruguayensis</i> (E. A. Smith, 1885)	-	-	-	1	-	-	7	-	-	-	-	-	8
	<i>Strigilla carnaria</i> (Linnaeus, 1758)	22	5	-	-	-	-	-	-	-	-	-	-	27
	<i>Strigilla pisiformis</i> (Linnaeus, 1758)	27	-	-	-	-	-	-	-	-	-	-	1	28
	<i>Strigilla producta</i> Tryon, 1870	-	-	-	-	1	-	-	-	-	-	-	-	1
	<i>Tellina angulosa</i> Gmelin, 1791	-	-	-	-	-	-	-	-	-	-	3	3	3
	<i>Tellina exerythra</i> Boss, 1964	-	-	-	-	1	-	1	1	1	1	2	7	7
	<i>Tellina martinicensis</i> d'Orbigny, 1853	-	-	-	-	-	-	-	-	1	-	-	1	1
	<i>Tellina punicea</i> Born, 1778	-	1	-	-	-	-	-	-	-	-	-	-	1
	<i>Tellina trinitatis</i> (Tomlin, 1929)	-	-	-	-	-	2	1	-	-	-	-	-	3
	<i>Tellina lineata</i> Turton, 1819	17	-	-	-	-	-	-	-	-	-	-	-	17
Family Solenidae	<i>Tellina versicolor</i> De Kay, 1843	-	12	-	-	-	-	-	-	1	5	-	-	18
Family Veneridae	<i>Solen tehuelchus</i> d'Orbigny, 1843	-	-	-	-	-	-	-	-	-	-	3	3	3
	<i>Callista maculata</i> Linnaeus, 1758	-	1	-	-	-	-	-	-	-	-	-	-	1
	<i>Chione cancellata</i> (Linnaeus, 1767)	-	1	-	-	-	-	1	-	-	-	-	15	17

TABLE 1. CONTINUED.

CLASSIFICATION	SPECIES	VOUCHER LOT NUMBERS (ZUEC)													A	B	C	D	E	F	G	H	I	J	K	L	TOTAL	
Family Cooperellidae	<i>Chione paphia</i> (Linnaeus, 1767)	3453, 3809 (Figure 3.36)													-	-	-	-	-	-	-	-	-	-	1	1	-	2
	<i>Chione pubera</i> (Bory Saint-Vincent,1827)	3451 (Figure 3.37)													-	-	-	-	-	-	-	-	-	-	1	-	1	
	<i>Chione subrostrata</i> (Lamarck, 1818)	3838													-	-	-	-	-	-	-	1	-	-	-	-	1	
	<i>Cyclinella tenuis</i> (Récluz, 1852)	3766, 3767, 3768, 3806, 3807 (Figure 3.39), 3808													-	-	1	-	1	-	3	1	-	-	-	-	6	
	<i>Dosinia concentrica</i> (Born, 1778)	2464 (Figure 3.40), 2465													-	-	-	-	-	-	-	-	-	-	-	2	2	
	<i>Pitar circinata</i> (Born, 1778)	1840 (Figure 3.41)													-	1	-	-	-	-	-	-	-	-	-	-	1	
	<i>Pitar fulminata</i> (Menke, 1828)	3441, 3442, 3810, 3811, 3812 (Figure 3.42), 3836, 3844													-	-	-	-	5	1	-	-	1	1	2	1	11	
	<i>Protothaca pectorina</i> Lamarck, 1818	1841, 1842													-	2	-	-	-	-	-	-	-	-	-	-	-	2
	<i>Cooperella atlantica</i> Rehder, 1943	2446, 3848 (Figure 3.44)													-	1	-	-	-	-	-	-	1	-	-	-	2	
	<i>Anatina anatina</i> (Spengler, 1802)	3847 (Figure 3.45)													-	-	-	-	-	-	-	-	1	-	-	-	1	
	<i>Mulinia cleryana</i> (d'Orbigny, 1846)	1982 (Figure 3.46), 1983, 3427													-	3	-	-	-	-	-	-	-	-	-	-	-	3
	<i>Mactra fragilis</i> Gmelin, 1791	3972 (Figure 3.47)													-	-	-	-	-	-	-	-	-	-	-	1	1	
Order Myoida																												
Family Corbulidae	<i>Carycorbula caribaea</i> d'Orbigny, 1853	1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 2458, 2459, 3428 (Figure 3.48), 3405, 3406, 3407, 3800, 3802, 3801, 3826													-	25	-	-	1	1	-	1	-	-	-	-	-	28
	<i>Caryocorbula chittyana</i> (C.B. Adams, 1852)	3849 (Figure 4.49)													-	-	-	-	-	1	-	-	-	-	-	-	-	1
	<i>Juliacorbula aequivalvis</i> (Philippi, 1836)	3803, 3804, 3805, 3846 (Figure 4.50)													-	-	-	-	-	4	-	-	-	-	-	-	4	
Order Anomalodesmata																												
Family Thraciidae	<i>Thracia similis</i> Couthouy, 1839	3822 (Figure 4.51)													-	-	-	-	-	-	-	-	-	-	-	1	1	
Family Periplomatidae	<i>Periploma ovatum</i> d'Orbigny, 1846	1978 (Figure 4.52)													-	1	-	-	-	-	-	-	-	-	-	-	-	1
	Total														56	91	1	1	10	9	13	4	10	10	73	110	388	
	Total species per collection station														3	19	1	1	6	5	4	4	9	7	15	20		

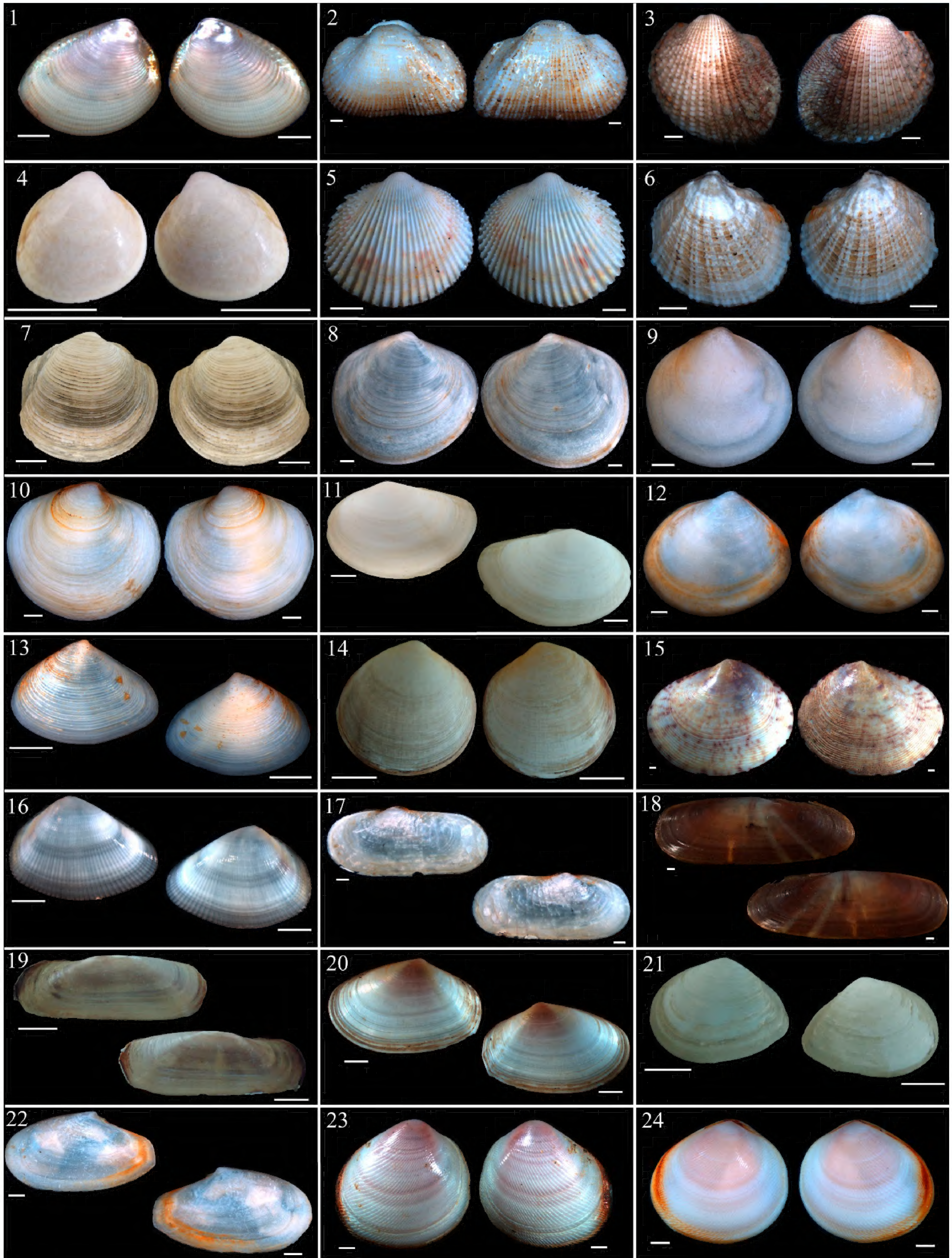


FIGURE 2. External view of right and left valves of the bivalves collected on the northern coast of the São Paulo State. (1) *Nucula semiornata* - ZUEC 3780; (2) *Arcopsis adamsi* - ZUEC 3823; (3) *Anadara chemnitzii* - TC; (4) *Laevicardium brasilianum* - ZUEC 3444; (5) *Trachycardium muricatum* - ZUEC 3437; (6) *Codakia pectinella* - ZUEC 3821; (7) *Lucina pectinata* - ZUEC 1843; (8) *Diplodonta punctata* - ZUEC 2472; (9) *Felaniella candeana* - ZUEC 3411; (10) *Phlyctiderma semiaspera* - ZUEC 3456; (11) *Sanguinolaria sanguinolenta* - TC; (12) *Abra lioica* - ZUEC 2454; (13) *Ervilia nitens* - ZUEC 3452; (14) *Semele proficua* - ZUEC 2482; (15) *Semele purpurascens* - ZUEC 3459; (16) *Donax gemmula* - ZUEC 3837; (17) *Solecurtus sanctaemarthae* - ZUEC 3771; (18) *Tagelus divisus* - TC; (19) *Tagelus plebeius* - TC; (20) *Macoma cleryana* - ZUEC 3454; (21) *Macoma constricta* - TC; (22) *Macoma uruguayensis* - ZUEC 3756; (23) *Strigilla carnaria* - ZUEC 1977; (24) *Strigilla pisiformis* - ZUEC 3786. Scale bars: Figs. 1-6, 8-10, 12-13, 15-18 = 1 mm; Figs. 7, 11, 14, 19 and 21 = 1 cm; Fig. 20 = 4 mm. Abbreviations: TC, Teaching Collection of State University of Campinas; ZUEC (voucher lot number), Museum of Zoology "Prof. Dr. Adão José Cardoso".

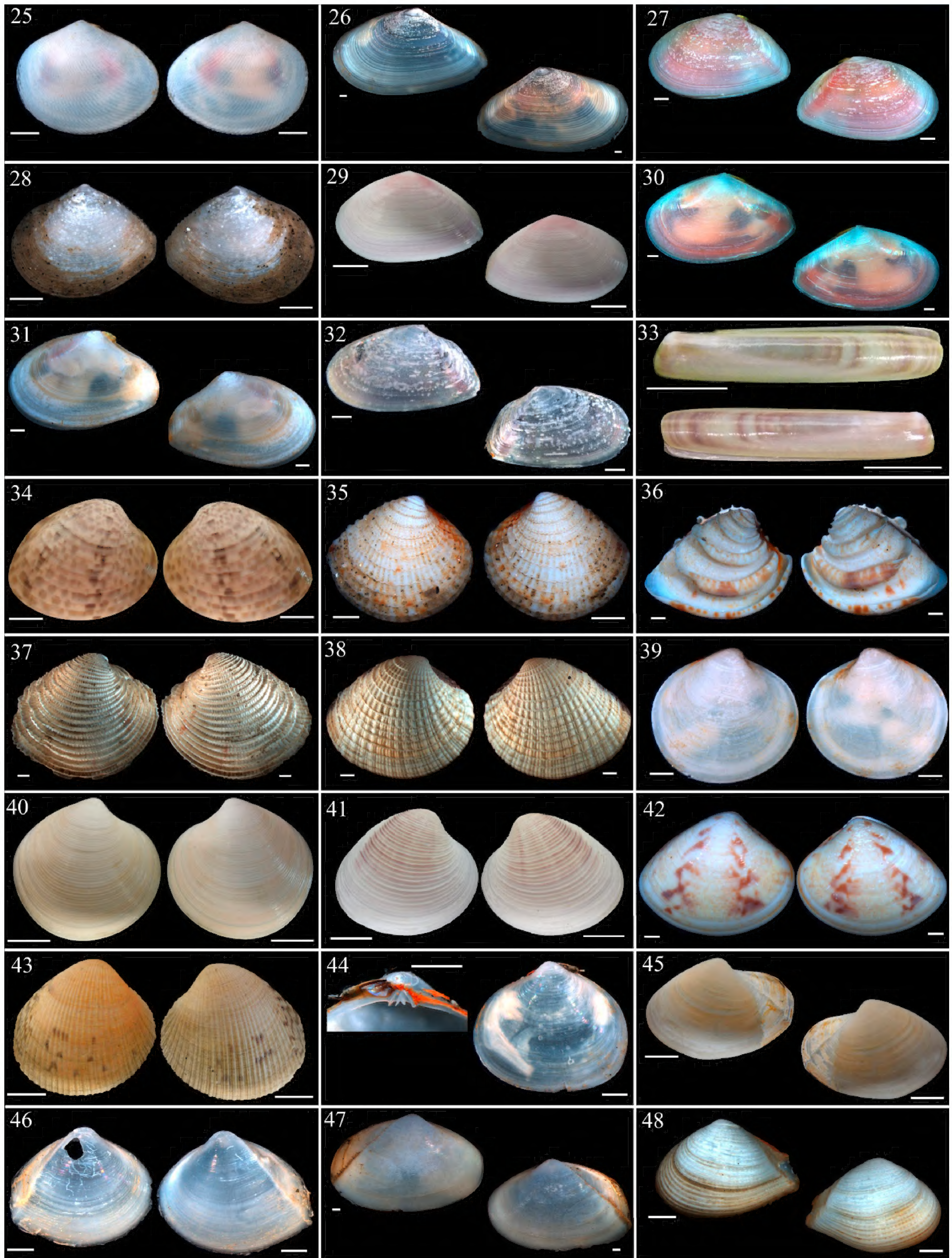


FIGURE 3. External view of right and left valves of the bivalves collected on the northern coast of the São Paulo State. (25) *Strigilla producta* - ZUEC 3814; (26) *Tellina angulosa* - ZUEC 3435; (27) *Tellina exerythra* - ZUEC 3816; (28) *Tellina martinicensis* - TC; (29) *Tellina punicea* - ZUEC 1967; (30) *Tellina trinitatis* - ZUEC 3813; (31) *Tellina lineata* - ZUEC 3831; (32) *Tellina versicolor* - ZUEC 1974; (33) *Solen tehuelchus* - TC; (34) *Callista maculata* - ZUEC 1849; (35) *Chione cancellata* - TC; (36) *Chione paphia* - ZUEC 3809; (37) *Chione pubera* - ZUEC 3451; (38) *Chione subrostrata* - TC; (39) *Cyclinella tenuis* - ZUEC 3807; (40) *Dosinia concentrica* - ZUEC 2464; (41) *Pitar circinata* - ZUEC 1840; (42) *Pitar fulminata* - ZUEC 3812; (43) *Protothaca pectorina* - TC; (44) *Cooperella atlantica* (right valve was damaged during the dissection, details of hinge plate of left valve) - ZUEC 3848; (45) *Anatina anatina* - ZUEC 3847; (46) *Mulinia cleryana* - ZUEC 1982; (47) *Mactra fragilis* - ZUEC 3972; (48) *Carycorbula caribaea* - ZUEC 3428. Scale bars: Figs. 25-32, 34-40, 42, 44 and 46-48 = 1 mm; Figs. 33, 41, 43 and 45 = 1 cm. Abbreviations: TC, Teaching Collection of State University of Campinas; ZUEC (voucher lot number), Museum of Zoology "Prof. Dr. Adão José Cardoso".

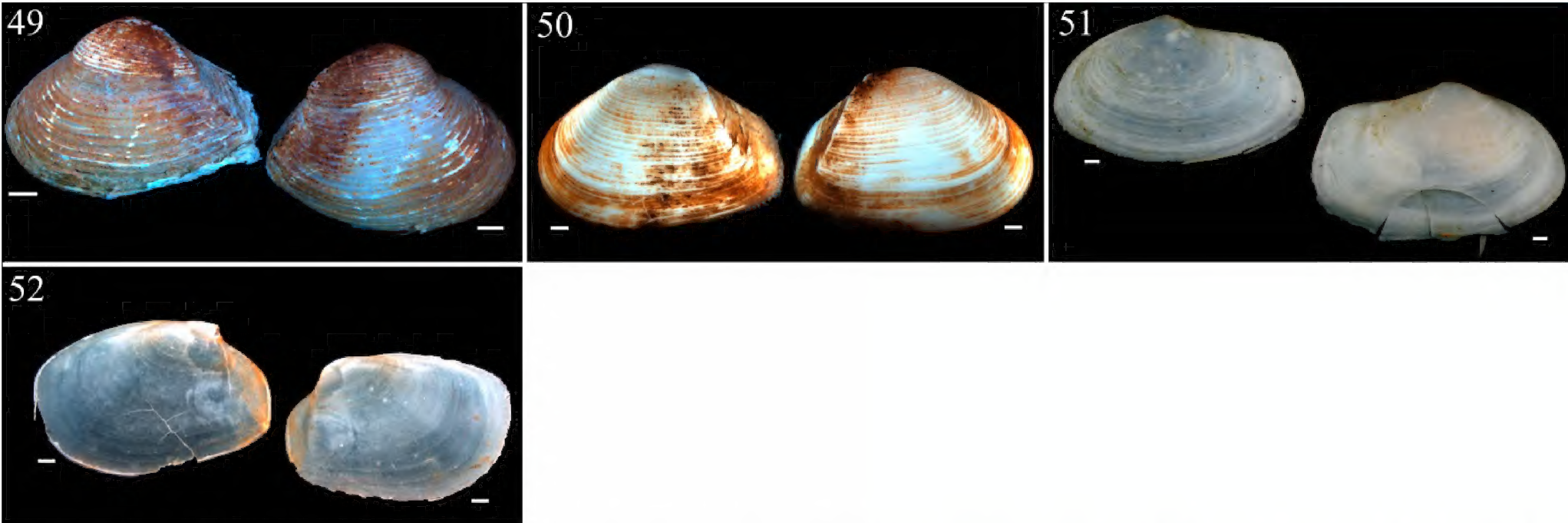


FIGURE 4. External view of right and left valves of the bivalves collected on the northern coast of the São Paulo State. (49) *Caryocorbula chittyana* - ZUEC 3849; (50) *Juliacorbula aequivalvis* - ZUEC 3846; (51) *Thracia similis* - ZUEC 3822; (52) *Periploma ovatum* - ZUEC 1978. Scale bars: 1 mm. Abbreviations: TC, Teaching Collection of State University of Campinas; ZUEC (voucher lot number), Museum of Zoology “Prof. Dr. Adão José Cardoso”.

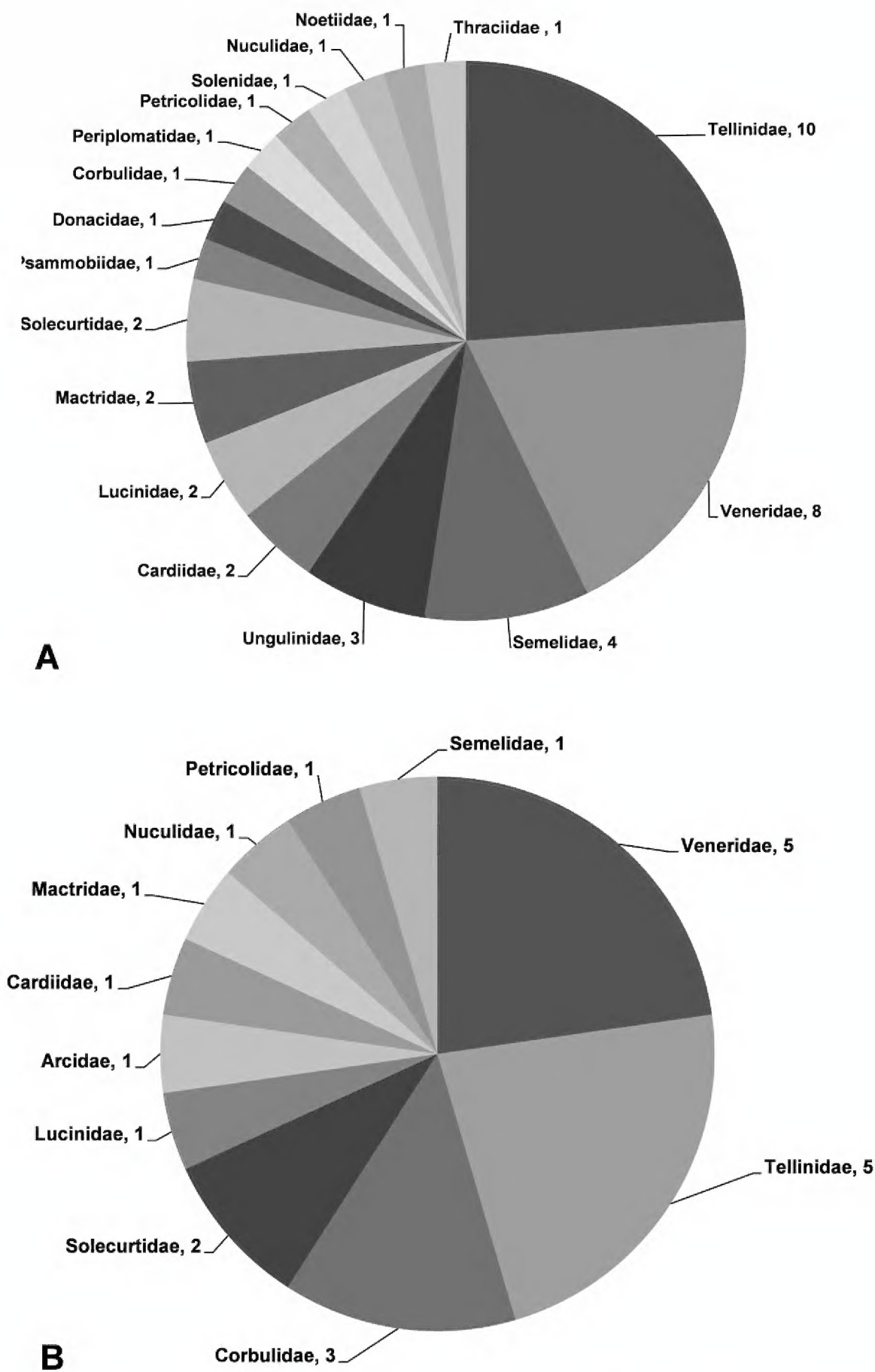


FIGURE 5. (A) Total of species per family collected in the intertidal zones of the São Sebastião and Ilhabela beaches, between 2010 and 2012. (B) Total of species per family of bivalves collected in 2012 in locations within the São Sebastião Channel.

ACKNOWLEDGMENTS: The study was supported by São Paulo Research Foundation (FAPESP) and Coordination for the Improvement of Higher Education Personnel (CAPES). The National Council for Scientific and Technological Development (CNPq) is acknowledged for the scholarship of A.C. and CAPES for the scholarship of F. M. M. The authors thank the Marine Biology Center, University of São Paulo (CEBIMar-USP), for facilitating the specimen gathering, and the referees, especially Robert G. Forsyth, for the critical review.

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RECEIVED: August 2013

ACCEPTED: December 2013

PUBLISHED ONLINE: February 2014

EDITORIAL RESPONSIBILITY: Robert Forsyth